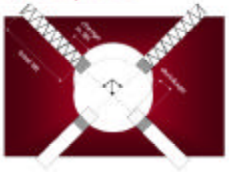
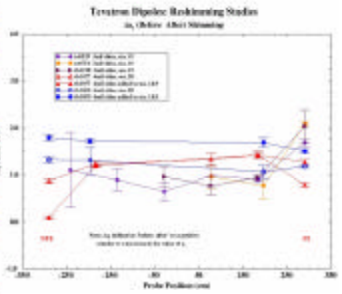
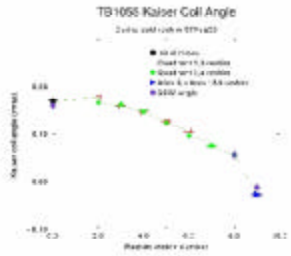
2) Strong Coupling in the Tevatron

An explanation for the strong coupling observed in the Tevatron was recently found. The coupling can be explained by a small skew quadrupole (a1) component in the magnetic field of the Tevatron dipole magnets. The a1 component was apparently introduced by creep in the G11 suspensions which are part of the mechanical support of the coils within the warm iron yoke. The suspension creep has caused the coils to drop on average by ~100 microns within the yoke. This shift produced, on average, 1 unit of a1 in the dipoles.

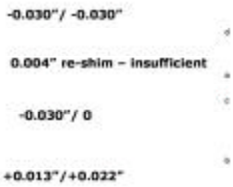




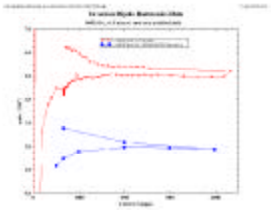
A reshimming demonstration experiment was conducted in July of 2003. Several dipoles were re-shimmed by 3-4 mils and magnetic measurements were performed before and after. These measurements were in support of the Sept 03 shutdown during which ~100 Tevatron dipoles were reshimmed.

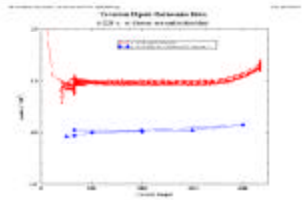


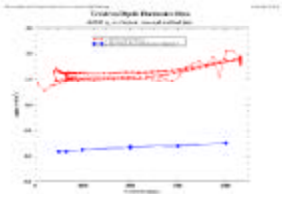
Roll measured with Kaiser coil, level-probe and stretched wire indicate a very small overall roll change during the re-shimming operation, which appears to occur almost entirely between coil and yoke (as evidenced by the fact that Kaiser coil and stretched wire measurements agreed).



Extreme reshimming was performed in one magnet to test the limits of the reshimming procedure. 30 mil shims were introduced non-symmetrically and the a1/b1 response of the magnet measured. Unexpectedly the data show no current dependence even at large coil offsets.



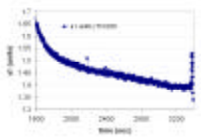




Examples of magnetic measurements of the a1 component in the 1980s and recently showing the increase of a1 by one unit.

3) Tune and Coupling Drift in the Tevatron

Tune and coupling (minimum tune split) drift is being observed in the Tevatron. There possible explanations for the effect are listed below. Currently favored is the feed-down hypothesis (# 1 in the list below). While the phenomenon is not entirely understood a feed-forward scheme, very similar to that for the b2 drift and snap-back compensation, was introduced in the Tevatron tune and coupling corrector program to compensate for



a1 drift during a 30 min injection porch found in TB0269

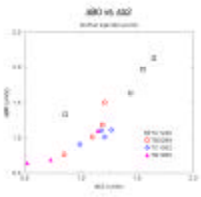
Possible explanations for the tune and coupling drift during injection in the Tevatron are:

–1– feed-down from the b2 to b1/a1 due to systematic horizontal/vertical beam off set (~ 1 mm) in the dipoles with respect to the sextupole correctors;

–2– drifting a1/b1 fields (~0.1 units) in the Tevatron dipoles;

–3- ~2 units of main field decay in the arc quadrupoles.

4) Other Dynamic Effects in the Tevatron Dipoles



Correlation of b0 and b2 drift in several recently tested dipoles.

As shown in the plot on the left the main field component in the dipoles shows drift-amplitudes (after 30 min at the injection porch), which are clearly correlated with the b2 drift amplitudes. This (expected) behavior indicates that these phenomena appear in all allowed multipoles, and therefore also in the decapole.
Drifts in the dipole field in the Tevatron dipoles cause Energy errors. They can also cause tune drifts, if the (relative) drift in the quadrupole field of the arc quadrupoles is not equal to the relative dipole drift. This would be an additional cause of tune drift that needs to be added to the list above.
Drifts in the decapole can cause time dependent differential chromaticity effects. It is not clear at this point what the impact on Tevatron operations would be.
These and other effects are also being studied in the context of this project.